The "Gains" from Preferential Trade Liberalization in the CGE Models: Where do they Come From?

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Table of Contents

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1. Introduction

In a series of papers, Bhagwati and Panagariya (1996), Bhagwati, Greenaway and Panagariya (1998) and Panagariya (1996, 1997a, 1998) have argued forcefully that a tariff preference by a country is likely to hurt itself and benefit its union partner. If the union members are small in relation to the rest of the world and the country giving the tariff preference imports the good from the partner as well as the rest of the world, the tariff preference has no impact on the country's internal price and hence the allocation of resources. Instead, to the extent of the tariff preference, the tariff revenue collected previously on the imports from the partner is transferred to the latter's exporting firms as additional profit. If the union members are large in relation to the rest of the world, the tariff preference leads to a deterioration of the country's terms of trade. In either case, the presumption is that the country loses from its own preferential trade liberalization.

A key implication of this argument is that, as a result of the North American Free Trade Agreement (NAFTA), which effectively amounted to one-way preferences by Mexico to the United States, Mexico was hurt and the United States benefited. This view has not gone uncontested, however. In fact, many Computable-General-Equilibrium (CGE) modelers, among others, have reached exactly the opposite conclusion. They contend that repeated exercises have shown that preferential liberalization is beneficial to the country undertaking such liberalization and that the trade-creation effect far outweighs trade-diversion effect. Robinson and Thierfelder (1999) have promoted this view as follows:

> "The results from a large number of model-based empirical studies strongly support a few robust conclusions about RTAs [Regional Trade Agreements]: (1) they increase welfare of participating countries; (2) aggregate trade creation is much larger than aggregate trade diversion…"

To be sure, not everyone agrees with this summary of model-based studies. Thus, not too long ago, after a careful survey of both *ex post* empirical studies and CGE models, Srinivasan, Whalley and Wooton (1993) had reached quite a different conclusion:[1]

> "We, therefore, see these studies as shedding somewhat incomplete and at times conflicting light on the effects of post-war RIAs [Regional Integration Agreements] on trade and welfare, to say nothing of what might be the likely effects of prospective RIAs. There seems to be near unanimity that trade creation occurred in Europe, but its size and the precise contribution of the RIAs relative to other factors is unclear. Nor is it clear that significant trade creation from RIAs has occurred elsewhere."

This very different conclusion notwithstanding, the issue remains as to the source of the gains from preferential liberalization in the group of CGE studies surveyed by Robinson and Thierfelder (1999). In this paper, we subject the CGE models, based on *conventional* theory, to a critical examination.[2] We argue that when these models generate benefits to a

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[1] *Ex post* studies refer to empirical analyses based on data before and after the formation of preferential trade arrangements and include assessments using the gravity-equation.

[2] This means that we do not examine the CGE models that rely on economies of scale, imperfect competition or changes in ex-efficiency to generate gains from preferential liberalization.

country from its own preferential liberalization, they do so by recourse to models characterized by internally inconsistent assumptions. And even within the wrong model structure, the gains are generated by choosing questionable values of some key parameters. If a theoretically correct *conventional* model is chosen, the CGE models are unlikely to generate positive benefits to a country from its own preferential liberalization. We hypothesize that in addition to the structure of the model and parameter values, investigators can abuse the specific functional forms used to operationalize the models. We do not investigate this hypothesis in this paper, however.

Unearthing the features of CGE models that drive them is often a time-consuming exercise. This is because their sheer size, facilitated by recent advances in computer technology, makes it difficult to pinpoint the precise source of a particular result. They often remain a black box. Indeed, frequently, authors are themselves unable to explain their results intuitively and, when pressed, resort to uninformative answers such as "trade creation dominates trade diversion" or vice versa. Cognizant of this problem, in this paper, we will provide our numerical examples using very simple and stylized models, which are strictly in conformity with theory and are fully transparent. The challenge to CGE modelers is to offer similar stylized counterparts of their models, so that others can examine the assumptions underlying them.

The paper is organized as follows. In Section 2, we present some simple, partial-equilibrium theory, which must form an integral part of any model of preferential liberalization. Relying on a homogeneous-good, small-union model, we already establish

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We suspect, however, that the critique in this paper will apply partially to the models in this category as well.

here a strong presumption that preferential liberalization by a country hurts itself and benefit the recipient of the preference. In Section 2, we argue that many CGE models from which Robinson and Thierfelder (1999) have drawn their conclusions, are fundamentally flawed in that they combine the Armington assumption with fixed terms of trade. The Armington assumption says that goods are differentiated by the country of origin. If that is the case, the goods produced by a country, no matter how small, are not supplied by any other country. The country necessarily has market power in these goods. Using stylized numerical examples, we then demonstrate that, with appropriate closure of the model, the results of Section 2 remain valid in the presence of product differentiation a la Armington assumption.[3] In Section 4, we show that many of the CGE models generate benefits from preferential liberalization by recourse to a wrong model and wrong parameter values. Using the right parameter values, even within this wrong model, is likely to lead to losses from preferential liberalization. In Section 5, we conclude the paper.

2. The Small-Union, Homogenous-Goods Model: A Partial Equilibrium Analysis

When goods are assumed to be homogeneous, the analysis of FTAs-- as distinct from CUs--is more complicated than normally realized. Under a customs union arrangement, both producer and consumer prices are equalized within the union. But under an FTA, as Richardson (1994) has noted, while producer prices equalize, consumer prices do not. Free mobility of goods produced within the union ensures there is a single union-wide price for them. But the goods imported from outside pay a different duty depending on

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[3] Alternatively, we can introduce product differentiation via the Krugman (1980) model,

the country in which they are consumed, leading to differences in consumer prices between member countries. This feature of FTAs gives rise to effects that are more complicated than those obtained under a customs union arrangement. This is shown below, building on the analyses of Grossman and Helpman (1995) and Bhagwati and Panagariya (1996).

Consider the usual three-country setting, with A, B and C denoting the three countries. Countries A and B are potential members in a union while C represents the rest of the world. In this section, we assume that A and B are small in relation to C. Given the assumption that goods are homogeneous, the "small-union" assumption translates into "price-taking" behavior by A and B.

In this section, we limit ourselves to a partial-equilibrium model in which the FTA consists in country A removing a single tariff on B but not C. We begin with the assumption that the good under consideration, called steel, is imported by A and exported by B. We further assume that, being an exporter, B does not impose a tariff on steel. The cases in which B levies a tariff (even as an exporter) or is an importer of the product in the initial equilibrium are discussed later. Based on the pattern of trade among A, B and C before and after trade, three analytically distinct cases must be considered.

Case 1: Country A Imports Steel from C Before and After the FTA.

In this case, since the pre-FTA tariff continues to apply to imports from C and the latter's supply price is fixed via the small-country assumption, the internal price of steel in A is unchanged. Consequently, the tariff preference has no impact on the output, consumption and total imports into A. The change brings about no trade creation. At the same time, the

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which is theoretically more satisfactory. Our results are preserved in this case.

tariff preference allows B to partially replace C as the source of imports even though its marginal cost of production is higher than that of the latter. This trade diversion leads to a net loss to the union as a whole.

As far as country A alone is concerned, its losses exceed those arising solely from trade diversion. In particular, they equal the tariff revenue foregone on the imports coming from B; the more A imports from B in the post-union equilibrium, the more it loses. Country B, in turn, benefits from the union, since its exporters capture the tariff revenue not collected by A. Effectively, intra-union terms of trade shift in favor of B by the full amount of the tariff preference. Country B's net gain equals the revenue transfer via improved terms of trade minus the welfare cost of trade diversion.

These results are derived in Figure 1. The left-hand panel in the figure shows the market for steel in country B and the right-hand panel the import-market in country A. D_BD_B and S_BS_B represent the demand for and supply of steel, respectively, in country B. P_C represents the price of steel in the rest of the world. In the absence of a tariff preference, the export-supply curve of B is given, as usual, by the difference between its supply and demand curves. This is represented by E_BE_B in the right-hand panel.

Curve M_AM_A in the right-hand panel represents country A's import-demand curve, obtained by subtracting its domestic supply from demand. The horizontal line P_CP_C is C's perfectly elastic supply curve. Initially, A imposes a non-discriminatory tariff at rate $P_CP_C^t$. Consequently, export supply curves of B and C, as perceived by agents in A, are given by $E_B^tE_B^t$ and $P_C^tP_C^t$, respectively. The domestic price in A is established at P_C^t. The country imports quantity GS, of which GF comes from B and FS from C. Country A collects $P_CP_C^t$ per unit in tariff revenue, leaving a net price of P_C for both B and C.

Suppose now that A eliminates the tariff on B but not C. Steel producers in B now have access to A's internal price. Since the price in their own home market is P_C, they have no incentive to sell steel there: they divert their entire quantity of steel to A. Therefore, after the tariff preference, the export supply from B shifts all the way to S_BS_B rather than E_BE_B, where S_BS_B resembles B's *total* supply curve of B as shown in the left-hand panel. All of B's demand for steel is now satisfied by imports, while all of its domestic supply is sold in A at the improved terms of trade, P_C^t.

By assumption, B's total supply of steel at P_C^t is less than A's demand for imports, so that imports continue to come from C. With the original tariff still applied to country C, the internal price in A remains unchanged. This means that the total imports of steel are also unchanged at GS. The union is wholly trade diverting: A's imports from B rise from GF to GN, without any expansion of total imports.

It is readily verified that the tariff preference by A results in a loss of rectangle GNEH to itself, a gain of trapezium GNJH to B, and a net loss of triangle NEJ (= UKL in the left-hand panel) to the union as a whole. Country A loses GFEH because it is no longer able to collect tariff revenue on steel imports from B, GN. Alternatively, we can view the loss as resulting from a deterioration of A's intra-union terms of trade: rather than P_C, it now pays P_C^t on imports from B. Country B gains area GNJH because its exporters are able to get A's higher internal price. The tariff revenue on the import quantity GF, previously collected by A, becomes a part of export revenue earned by B's firms. Of this, area NEJ constitutes a net deadweight loss due to the higher cost of production of quantity JE in B than in C. This area is the net cost to the union as a whole of extending A's protection to B's firms.

An important point that deserves noting is that, though the total quantity of trade diverted from C to B is WE =WJ+JE, the diversion of WJ imposes no welfare cost on the union. This is simply because imports from the rest of the world into the union as a whole decline by JE (=UL in the left-hand panel), not WE. With all of B's supply diverted to A, the former now satisfies its domestic demand entirely through imports. By construction, these imports, represented by P_CV in the left-hand panel of Figure 1, equal WJ in the right-hand panel.

This analysis is extended easily to the cases in which (i) B is an exporter of steel in the initial equilibrium but happens to keep a tariff on imports on its books, and (ii) A and B are both importers of steel and impose tariffs on imports. Thus, assume that the tariff in B is lower than that in A. In case (i), the tariff in B is redundant initially, yielding the same pre-preference equilibrium as in Figure 1. But in the post-preference equilibrium, as steel producers in B divert their supply to A (since, given the higher tariff, the price is higher there) and domestic demand has to be satisfied by imports, the tariff becomes effective. There is an increase in the price of steel in B, a decline in its consumption, and a concomitant loss of welfare. This loss is over and above triangle JNE in the right-hand panel of Figure 1 (= KLU in the left-hand panel).

In case (ii), the tariff is effective in the pre-preference equilibrium, with the price in B exceeding that in C by the amount of tariff per unit. Under the FTA, both A and B remove the tariff on steel on each other. Since the external tariff, and, hence, the price of steel is higher in A, B's output is diverted to A as before. The difference with the original case, however, is that the height of the triangle representing the loss from trade diversion in the right-hand panel in Figure 1 is now measured by the difference between tariff rates in A and B. Moreover, there is no additional loss in consumption in B that occurs in case (i). Both results follow from the fact that the pre-preference price in B is already equal to the world price plus its tariff.

In concluding this case, it is important to emphasize that, as far as the welfare of an individual union member is concerned, the resdistributive effect of a tariff preference is likely to overwhelm the efficiency effect. Whereas the resdistributive effect is represented by a rectangle whose base is the *total* quantity of intra-union trade, the efficiency effect is represented by a triangle whose bases is the *change* in trade. Country A, which gives the tariff preference, losses potential tariff revenue on the entire quantity of steel imported from B. And if it imports a large quantity of steel from its partner, this loss will be large. Even if the preference was to give rise to trade creation (see the next case below), since the corresponding welfare gain will be a triangle built on the *increase* in intra-union trade over and above the diverted quantity, the net effect on A is likely to be negative. More generally, in a many-goods setting, if one partner has high tariffs and the other low tariffs (Mexico and U.S.A., respectively, in NAFTA) and bilateral trade between them is approximately balanced, an FTA is likely to hurt the former and benefit the latter.

Case 2: Country A Imports Steel from C Before but not After the FTA.

The results in the previous sub-section notwithstanding, the consensus view in the literature is that a preferential reduction in tariff has an ambiguous effect on the welfare of the country giving the preference and the union as a whole. What is surprising, however, is that in the small-union context, this ambiguity almost always relies on the assumption that the good subject to the preference is either not imported from the rest of the world or the preference eliminates the latter as a source of imports. The pioneering contributions of both

Viner (1950) and Meade (1955) implicitly make use of this property. Recall that in the Vinerian formulation, the supply price of the rest of the world as well as the union partner is assumed to be constant. In this setting, if the good is initially imported from the rest of the world, a tariff preference has no impact unless it eliminates the latter as a supplier. Similarly, the Meade model explicitly assumes that the good imported from the partner is not imported from the rest of the world in either pre- or post-FTA equilibrium.

Figure 2 shows formally how the elimination of the rest of the world as a source of imports opens the door to beneficial effects of a tariff preference. In this figure, we reproduce the right-hand panel of Figure 1 with the difference that B's supply curve, S_BS_B, crosses A's import-demand curve, M_AM_A, below the tariff-inclusive price of C (point S). Given its large supply of steel, B now eliminates C as a source of imports into A in the post-FTA equilibrium. Steel price in A is, thus, delinked from P_C^t. Instead, the price is determined by the intersection of A's import-demand curve and B's supply curve.

It is a straightforward matter to see that the net effect of the tariff preference by A is now ambiguous on itself and the union as a whole and, as before, non-negative on B. With the decline in the internal price, new trade in the amount KL is created, which is associated with a rise in the union's welfare equal to triangle SLU. At the same time, since A's protection is extended to B's firms, there is harmful trade diversion: the cost of production of units ZV (previously imported from C) in B exceeds that in C by area UVZ. The union as a whole gains or loses as area SLU is larger or smaller than area UVZ. The farther to the right does S_BS_B lie, the larger is SLU and smaller UVZ. In the limit, if S_BS_B crosses P_CP_C at or to the right of V, area UVZ disappears altogether and the union as a whole necessarily benefits.

The effect of the tariff preference on A is also ambiguous. In Figure 2, it gains area SKL from trade creation but loses area WKVH due to tariff-revenue transfer. The farther to the right B's supply curve lies, the closer is A's internal price to P_C and more likely that it will be a net gainer. In the limit, if the internal price drops to P_C, no revenue transfer to B takes place and there is benefit from trade creation, implying a net gain.

The effect on B's welfare is non-negative. As drawn in Figure 2, the price received by its exporters as well as the quantity of exports rises. It benefits on both counts, receiving a net gain of WLZH. In the limiting case when B's supply is sufficiently large that the price in A drops to P_C, it makes no gain but it also does not lose.

Case 3: Country B Exports Steel to C Before and After the FTA.

The analysis of the previous two cases shows that the possibility of positive gains from preferential liberalization for A and the union as a whole arises only when the rest of the world is eliminated as A's trading partner. This suggests an even more extreme case as a candidate for welfare-improving preferential liberalization: if the partner exports the product to the rest of the world both before and after the union is formed, intra-union terms of trade cannot change as a result of preferential liberalization by A. And if intra-union terms of trade do not change, the revenue-transfer effect is eliminated entirely. Any tariff preference, granted by A, results in an equivalent decline in its domestic price, with tariff revenue transferred to its own consumers rather than B's exporters.

As the reader can readily verify, this case arises when $E_B^tE_B^t$ in Figure 2 crosses M_AM_A at or below point R. In this case, both in the initial and final equilibrium, B exports steel to country C. The price received by firms in B never rises above P_C and there is no revenue transfer from A to B. Preferential liberalization essentially mimics nondiscriminatory liberalization with Country A benefiting and country B remaining unaffected.

To anticipate the analysis in the following sections, especially Section 4, it may be noted that, in general equilibrium, the assumption that the partner exports its good to the rest of the world before as well as after the tariff preference is not be sufficient to rule out trade diversion. There may be goods that are imported from the rest of the world that are not imported from the partner and are substitutes for the latter's good. In such a situation, a tariff preference to the partner lowers the imports from the rest of the world and, thus, gives rise to trade diversion indirectly. And since the good imported from the rest of the world is likely to be subject to a tariff, such trade contributes negatively to welfare.

3. A General-Equilibrium Model with Product Differentiation by Country of Origin

In assessing the effects of FTAs, CGE analysts rarely use homogeneous-goods models. Instead, they take resort to the so-called Armington assumption, according to which products are differentiated by the country of origin. For example, Mexican, U.S. and the rest of the world's steel are modeled as different products. Correspondingly, in consumer preferences, the three types of steel are represent as substitutes via a constant-elasticity-of-substitution (CES) function.

It would seem that once goods have been redefined this way, the revenue-transfer effect, which played the dominant role in the previous section, would disappear altogether. For in this case, country B must export its steel to both A and C before as well as after the formation of the FTA. Assuming the prices in the rest of the world to be fixed via the small-country assumption, we are effectively in the realm of case 3 of the previous section. The revenue-transfer effect cannot arise.

A moment's reflection shows that this conclusion is based on an incorrect application of the small-country assumption, however. The key point, which the CGE modelers under review overlook, is that product differentiation by country of origin is incompatible with fixed terms of trade. That is to say, if goods are assumed to be differentiated by the country of origin, the terms of trade in the rest of the world or the union cannot be assumed to be fixed. And if the terms of trade are not fixed, the revenue-transfer effect, re-enters the analysis through a deterioration of intra-union terms of the country extending the tariff preference.

The logic behind why product differentiation is incompatible with fixed terms of trade is simple: by assumption, each country is the sole producer of its products and, hence, enjoys monopoly power over it. This point has been made formally in the context of the monopolistic-competition model in an important paper by Gros (1987) and is reproduced in the recent textbook by Bhagwati, Panagariya and Srinivasan (1998).

Since many CGE modelers have continued to ignore this important point in their applications to preferential trading, it is worth making it explicitly in the context of the Armington assumption. This is done most simply in a two-good, two-country model in which each country produces one good. Call the two countries A and B and label their products 1 and 2, respectively. Assume, as the CGE models do, that preferences are CES.

We know that, in this setting, the optimum tariff of A on B equals $1/(\eta_1^*-1)$, where η_1^* is B's elasticity of demand for imports of good 1. Of course, since good 1 is not produced in B, the import-demand elasticity coincides with the total-demand elasticity of good for the good. What we need to do to obtain the optimum tariff, therefore, is to derive the elasticity of demand for good 1 in B in the Armington model. This is readily done by recourse to country B's first-order condition of utility maximization and the budget constraint.

Distinguishing B's variables by superscript B, let p_i^B and C_i^B, respectively, represent the price and consumption of good i (i = 1, 2) and σ^B the elasticity of substitution in consumption between the two goods in B. Assume that good b is the numeraire so that $p_2^B \equiv 1$. Using a hat (^) to denote the proportionate change in a variable, the first-order condition of utility maximization and the budget constraint, respectively, may be written in defferential form as

(1) $$\hat{C}_1^B - \hat{C}_2^B = -\sigma^B \hat{p}_1^B$$

(2) $$p_1^B C_1^{*B} (\hat{p}_1^B + \hat{C}_1^B) + C_2^B \hat{C}_2^B = 0$$

Solving these equations for the proportionate change in C_1due to a change in p_1, we obtain

(3) $$\eta_1^B \equiv -\frac{\hat{C}_1^B}{\hat{p}_1^B} = \frac{\sigma^B C_2^B + p_1^B C_1^B}{p_1^B C_1^B + C_2^B}$$

From this expression, we can write the optimum tariff of country A as

(4) $$t_{opt}^A = \frac{1}{\eta_1^B - 1} = \frac{p_1^B C_1^B + C_2^B}{C_2^B} \frac{1}{\sigma^B - 1}$$

The first fraction in the last equality remains larger than unity, no matter how small country A becomes. In the limit, as A becomes infinitesimally small, the fraction approaches unity and the optimum tariff approaches $1/(\sigma^B-1)$. If we assume $\sigma^B = 2$, not an unusual assumption in the CGE models, the optimum tariff for a small country in this set up is 100%; a far cry from the fixed terms-of-trade interpretation of the small-country assumption employed by CGE analysts!

The feature that the Armington assumption necessarily implies market power on the part of each country, no matter how small, has far-reaching implications for the analysis of FTAs. For, with union members' goods not even produced in country the rest of the world, we can no longer fix their prices in the latter. Any liberalization by a country, preferential or otherwise, alters its terms of trade, which must be taken into account in the calculation of the welfare effects.

Once we bring the terms-of-trade changes into our calculations, the revenue-transfer effect, emphasized in the previous section, comes back to haunt us. For, even a preferential reduction in the tariff worsens a country's terms of trade vis-à-vis its partner, thereby redistributing partially the tariff revenue to the union partner. And if the initial tariff on the partner is lower than the "optimum" tariff, as is likely to be the case in view of the substantial unilateral liberalization in recent years, the deterioration in the terms of trade will also be accompanied by a deterioration in the country's welfare.

Mundell (1964) recognized this fact in a somewhat neglected paper, published more than three decades ago.[4] Assuming substitutability and low initial tariffs, Mundell reached the following dramatic conclusions:

(1) A discriminatory tariff reduction by a member country improves the terms of trade of the partner country with respect to both the tariff reducing country and the rest of the world, but the terms of trade of the tariff-reducing country might rise or fall with respect to third countries.

[4] Panagariya (1997a, 1997b) further elaborates on Mundell's (1964) analysis.

(2) The degree of improvement in the terms of trade of the partner country is likely to be larger the greater is the member's tariff reduction; this establishes the presumption that a member's gains from a free trade area will be larger the higher are initial tariffs of partner countries (Mundell 1964, 8)

These conclusions closely resemble those derived in the previous section for the small-union, homogeneous-goods, partial-equilibrium model.

To gain insight into how this "large-union" effect matters in determining the effects of preferential liberalization, we can simulate a three-country version of the model just discusses. The model itself can be summarized by a handful of equations, using the dual approach.

Throughout, use superscript j (j = A, B, C) to denote a country and subscript i (i = 1, 2, 3) to denote a good. By assumption, good 1 is produced exclusively by A, good 2 by B and good 3 by C. All goods are consumed in all countries. Denote by p_i the price of good i in the country where it is produced. To wit, p_1 is the price of good 1 in country A, p_2 of good 2 in B, and p_3 of good 3 in C. Domestic prices can be then computed with the help of tariff rates. Thus, letting t_i^j (i = 1, 2, 3 and j = A, B, C) denote the ad valorem tariff rate on good i in country j, where $t_1^A = t_2^B = t_3^C = 0$, the domestic price of good i in country j is given by good $(1+t_i^j)p_i$.

Assuming identical CES preferences that are identical across individuals within a country but can differ between countries, the expenditure function of the representative individual in country j can be written

$$(5) \qquad E^j(.) = [\sum_{i=1}^{3}(1+t_i^j)p_i\}^{1-\sigma}]^{\frac{1}{1-\sigma}}.u^j \qquad j = A, B, C$$

where u^j is the (endogenous) level of utility of the representative individual in country j and σ is the common elasticity of substitution in consumption. The same elasticity of substitution is assumed across countries. Since the purpose here is to focus on the role of the-terms-of-trade effects, no asymmetries are introduced in tastes across products or countries. We will return to focus on some of these differences in the next section in a model, which abstracts from the terms-of-trade effects.

$E^j(.)$ contains all the relevant information on the representative individual's demand. In particular, its first partials with respect to domestic prices give his compensated demand functions. To wit, the compensated demand for good i of the individual in country j is given by

$$(6) \qquad E_i^j(.) = \{(1+t_i^j)p_i\}^{-\sigma}[\sum_{i=1}^{3}(a_i^j)^{\sigma}\{(1+t_i^j)p_i\}^{1-\sigma}]^{\frac{\sigma}{1-\sigma}}.u^j \qquad j = A, B, C$$

$$= \{(1+t_i^j)p_i\}^{-\sigma}.\{(E^j(.)\}^{\sigma}u^j \qquad j = A, B, C$$

Turing to the supply side, assume that labor is the only factor of production and that each individual supplies one unit of labor. Thus, country size varies directly with the size of total number of individuals, which we denote by L^j. Assume further that one unit of labor produces $\overline{x}_1$ of good 1 in A, $\overline{x}_2$ of good 2 in B and $\overline{x}_3$ of good 3 in C. Letting tariff revenue be redistributed equally across individuals, the representative individual's income in country j, at domestic prices, can be written

$$(7) \qquad Y^j(.) = p_k\overline{x}_k + \sum_{i=1}^{3} t_i^j p_i E_i^j(.) \qquad j = A, B, C.$$

The first of these terms is the value of output, produced by the individual, and the second one his share of tariff revenue. By assumption, country A produces only good 1, B only good 2 and C only good 3. This fixes subscript k in the first term of (7) to k = 1, 2 , 3, respectively as j = A, B, C.

The budget constraint of the representative individual requires $E^j(.) = Y^j(.)$. Therefore, after substitution from (6) into (7) and combining the resulting equation with (5), we can write the budget constraint of country j as

$$(8) \qquad [\sum_{i=1}^{3}\{(1+t_i^j)p_i\}^{1-\sigma}]^{\frac{1}{1-\sigma}}.u^j = p_k \bar{x}_k^j + \sum_{i=1}^{3} t_i^j p_i \{p_i(1+t_i^j)\}^{-\sigma}\{E^j(.)\}^{\sigma}u^j \quad j = A, B, C.$$

We let good 1 be the numeraire and set $p_1 = 1$. This leaves p_2 and p_3 as the only prices to be determined endogenously. Once again, making use of (5), market-clearing conditions for goods 2 and 3 can be written

$$(9) \qquad \sum_{j=A,B,C}[L^j\{p_i(1+t_i^j)\}^{-\sigma}\{E^j(.)\}^{\sigma}u^j] = \bar{x}_i L^h \quad i = 2, 3.$$

On the right-hand side, we set h = B, C, respectively, as i = 2, 3. Thus, recalling that L^h represents the total supply of labor in country h, for i = 2, the right-hand side represents the total world supply of good 2 and when i = 3, it gives the total world supply of good 3. Since L^j also represents the total number of individuals in country j, $L^jE_i^j(.)$ represents that country's *total* demand for good i. Summing these over j and taking account of (6), as in the left-hand side of (9), we obtain the total world demand for good i. Thus, (9) equates the total demand for good 2 equal to its supply and similarly for good 3. We do not write the market-clearing condition for good 1 since it is redundant by Walras's Law and can be derived using (8) and (9).

We have five equations in (8) and (9) [with $E^j(.)$ defined by equation (5)], which can be solved for five endogenous variables, p_2, p_3, u^A, u^B, and u^C. Thus, duality allows us to neatly summarize a three-country model in just five equations. Taking specific parameter values of σ, per-worker outputs, labor supplies, and tariff rates, we can solve the model numerically.

In Table 1, we present the results of several simulations exploring the role played by different tariff rates. To fix the context, we choose the relative values of L^j and $\bar{x}_i$ so that the relative sizes of A, B and C approximately resemble those of Mexico, the United States and the rest of the world, respectively. We report several simulations for σ = 2 and 10 and tariff rates of 15% and 30%.

Cases 1-3 consider preferential liberalization by A alone. In Case 1, only A has a tariff initially, in Case 2, both A and B have a tariff and in Case 3, all countries have a tariff. Within our stylized model, case A1 best approximates NAFTA. For, under NAFTA, Mexico gave virtually all tariff preferences. An FTA in this case simply amounts to A eliminating its tariff on B, holding the tariff on C unchanged. In all four cases (σ = 2, 10 and $t_2^A = t_3^A = .15, .30$), A loses from the change. For σ = 2, the reduction in A's income from preferential liberalization is .7% at 15% tariff and 2.2% at 30% tariff. For σ = 10, these reductions become 2.3% and 5.7%, respectively. At the higher value of σ, the terms of trade vis-à-vis the rest of the world shift less and the revenue transfer effect is larger. The tariff preference uniformly benefits B and hurts C. But since both are very large in relation to A, the impact on them is very small. The results are similar in Cases 2 and 3, with the largest loss to A of 6.4% arising in Case 2 for σ = 10 and tariff of 30%. These results are contrary to the results CGE modelers reported during the NAFTA debate.

Case 4 and 5 present the results of mutual tariff preference by A and B. In Case 4, only A and B impose tariffs in the initial equilibrium while C adheres to free trade. In Case 5, C also has a tariff. Now the results are exactly the opposite of those in Cases 1-3.

Gaining a preferential access to B's large market, A is now a big winner. In Case 5, with σ = 10 and initial tariffs in A and B of 30%, mutual preferential liberalization leads to a 14% rise in A's real income. The effect on B is negligible. What may be surprising, however, is that when C also levies a tariff (Case 5), B actually loses. But it is an entirely plausible outcome: the loss to B from its own preferential liberalization can outweigh the gain from the partner's preferential liberalization. This is more likely when the outside country levies a tariff as well. For in this case, the optimum tariffs of A and B on each other (and C) are also higher.

A final set of simulations (Cases 6-8) report on the effects of MFN tariffs relative to multilateral free trade. In Case 6, all three countries levy a tariff, in Case 7, A and B levy a tariff but not C, and in Case 8, only A levies a tariff. Relative to free trade, for σ= 2, a 30% MFN tariff by all countries results in a loss of GDP of 11.16% for A, 3% for B and .6% for C. For σ = 10, these losses jump to 18.54% for A, 7.1% for B and 2.48% for C. At the other extreme, in Case 8, a 30% tariff by A results in a gain of 1.36% to itself when σ = 2 and a loss of .65% when σ = 10. In the former case, A's optimum tariff is higher than in the latter case. A key implication of these results is that, at low tariffs, a one-percentage point reduction in tariffs by other countries is much more valuable to a small country than an equivalent reduction in its own tariffs.

These results should serve as a warning to the reader against taking any CGE results seriously, without carefully examining the underlying structure of the model and parameter values. By choosing a three-country structure in which one country is very small relative to others, even within a conventional model, we are able to generate welfare effects of trade policy that are much larger (a decline of 18.54% in income for country A) than these models are known to generate. Furthermore, by changing the value of just one parameter, σ, we are able to turn a .6% loss to C into a 2.48% loss, a six-fold increase.

4. Generating Positive Gains: Wrong Model, Wrong Parameters

The analysis and simulations in the previous two sections establish a very strong presumption in favor of the view that *conventional* models yield the following results at tariff rates that are 30% or lower:

(i) Preferential liberalization by a country results in losses to itself and gains to its union partner;

(ii) If the union is small and the introduction of preferential trading does not eliminate trade with the rest of the world in a large number of products, the union as a whole loses; and

(iii) The union as a whole can benefit from preferential liberalization if trade diversion leads to an improvement in its terms of trade vis-à-vis the rest of the world. In this case, the rest of the world is hurt, making preferential liberalization a "beggar thy neighbor" policy.

These results lead to the puzzle: how do CGE modelers generate gains from preferential liberalization to the country undertaking such liberalization in the conventional models? We will demonstrate in this section that this is done by recourse to wrong models *and* wrong parameter values.

The first trick the CGE modelers use is to superimpose the small-country assumption on the Armington assumption. We have already argued at length that this is erroneous; within the usual CGE structure with CES preferences, the Armington assumption is incompatible with the small-union assumption, unless we assume that the elasticity of substitution in the rest of the world is infinity. But there is no justification for such an assumption: why should individual preferences exhibit such an extreme property and only in the rest of the world?

It is tempting to invoke the Meade-Lipsey, small-union model [Lipsey (1958)] to justify the small-union structure used by the CGE analysts. In this model, union members are assumed to be small and specialize in the good they export. But this justification poses serious dilemmas for CGE modelers. The small-union assumption is validated in the Meade-Lipsey model by assuming that goods are homogeneous and that the products exported by union members are also produced in the rest of the world [Lloyd (1982) and Panagariya (1997a, 1997b)]. Thus, the model relies on a structure different from that required for validating the Armington assumption. This is a substantive distinction; for, if we assume that the rest of the world produces all goods, the assumption that a union member does not import *any* good from it that it imports from the union partner is quite unrealistic. The CGE modelers cannot have it both ways. If they want to justify the small-union assumption via the assumption that the rest of the world produces all goods, they must admit the possibility that goods imported from a union partner are also imported from the rest of the world. In that case, they will be faced with the revenue-transfer effect discussed in Section 2. If they want to avoid this possibility by invoking the Armington assumption, they must give up the small-union assumption and, in turn, incorporate the terms-of-trade effects discussed in Section 3.

Indeed, we will argue that if the objective is to measure the effects of preferential liberalization, the Meade-Lipsey, small-union model offers the least attractive setting. It combines fixed terms of trade in the rest of the world with a structure of trade in which the good imported from the partner is not imported from the rest of the world in the initial or final equilibrium. The partner, in turn, exports the good to the union member as well as the rest of the world before and after the introduction of preferential trading. These assumptions lead to the outcome that preferential liberalization by a member has no impact whatsoever on its union partner and vice versa. All effects of preferential liberalization by a country are confined to itself. Under such a setting, why should any country form a preferential trade area in the first place? Whatever liberalization its wants to undertake, it can do on its own.

But suppose we go along with CGE modelers, make the small-union assumption and even accept the Armington assumption. That is to say, the terms of trade are fixed in C and that A exports good 1 to both B and C, B exports good 2 to both A and C and C exports good 3 to both A and B. Can we then generate gains from preferential liberalization? We will show that even in this implausible model, for plausible parameter values, preferential liberalization leads to losses and, when positive gains can be generated, they are too tiny to impress anyone.

As explained in Bhagwati and Panagariya (1996) and Panagariya (1997a, 1997b), under the small-union assumption, the central role is assumed by the relative degree of substitutability between different pairs of goods rather than the terms of trade. Before we turn to simulations, it is useful to reproduce this point analytically here. Since a member country is impacted solely by its own liberalization in this model, we need focus on only one country, say, country A. Moreover, since the number of individuals as represented by L^A plays no role in determining the outcome now (recall the terms of trade are fixed), we can set $L^A = 1$.

By appropriate choice of units, we can set all prices in country C equal to unity. Since A exports good 1, this good's domestic price is also 1. Good 2 is exported by B, for which it receives a price of 1 in C. Therefore, A must pay B the same price for this good at the border. Letting the tariff rate on the good to be t_2, this implies a domestic price of good 2 of $1+t_2$. Finally, good 3 is imported from C at a border price equal to 1 and is, therefore, priced at $1+t_3$ in A. With prices in A, thus, fixed entirely by its own trade policy, policy changes in the union partner, B, have no impact on it. By symmetry, policy changes in A have no impact on B.

Following the practice in CGE models, assume that the consumer's utility function is linear homogeneous.[5] We can then represent consumer demand via the separable expenditure function $e(1, 1+t_2, 1+t_3)u$, where e(.) is concave and linear homogeneous in its arguments and u is the level of utility. Letting $\overline{x}_1$ be the output of good 1 in A, the country's budget constraint can be written as

$$(10) \qquad e(1, 1+t_2, 1+t_3)u = \overline{x}_1 + t_2 e_2.u + t_3 e_3.u,$$

where e_2 is the first partial of e(.) with respect to $1+t_2$ and e_3 with respect to $1+t_3$. Remembering that $e_2.u$ and $e_3.u$, respectively, represent the quantities of goods 2 and 3 consumed and, hence, imported, the last two terms represent tariff revenue. It is assumed, as usual, that tariff revenue is redistributed to the consumer in a lump-sum fashion.

The tariff preference in this model is represented by a reduction in t_2, assuming $t_2=t_3$ initially. The idea is that goods imported from the potential partner and the outside country are close substitutes on which the initial tariff is the same. To see how such a tariff

[5] For our analytic results, this assumption is not required but it helps connect the model more directly to the specific CES utility function used in the CGE models.

preference affects A's welfare, differentiate (10) with respect to t_2. After some simplifications, we obtain

$$(11)\qquad (e - t_2 e_2 - t_3 e_3)\frac{du}{u} = [t_2 e_{22} + t_3 e_{33}]dt_2$$

Remembering that e_2 is homogeneous of degree zero in domestic prices, we have

$$(12)\qquad e_{21} + (1 + t_2)e_{22} + (1 + t_3)e_{23} = 0$$

Solving this equation for e_{22} and substituting into (11), we obtain

$$(13)\qquad (e - t_2 e_2 - t_3 e_3)\frac{du}{u} = -\frac{1}{1 + t_2}[t_2 e_{21} - (t_3 - t_2)e_{23}]dt_2$$

This is a familiar expression from the Meade-Lipsey model [Panagariya (1997a, 1997b)], which also obtains in the context of piecemeal tariff reform when we consider the effect of a unilateral reduction in a tariff, which is what the current exercise is about [equation (35.5) in Bhagwati, Panagariya and Srinivasan (1998)].

If all goods are normal in consumption, which is true for our linear homogeneous preference, the coefficient of du/u in (13) is positive. Therefore, a reduction in t_2 raises or lowers welfare, as the term in square brackets is positive or negative. If good 2 exhibits net substitutability with goods 1, e_{21} is positive, so that a small reduction in t_2 at $t_2 = t_3$ raises welfare. But if $t_3 > t_2$ at the initial equilibrium and goods 2 and 3 are also substitutes, the effect is ambiguous. For sufficiently small values of t_2, reductions in t_2 necessarily lower welfare.

The intuitive reason behind these results is well understood [see Bhagwati and Panagariya (1996)] and can be spelt out as follows. The reduction in t_2 expands the imports of good 2, which is beneficial trade creation [see the first term in (11)]. But it also leads a contraction of imports of good 3, which is harmful trade diversion [second terms in (11)].

The net effect depends on the relative magnitudes of the two effects. Net substitutability between goods 1 and 2 ensures that, at world prices, the tariff reduction expands the value of exports. Via the trade balance condition, this fact, in turn, implies that the value of imports of good 2 expands more than the value of imports of good 3 contracts. If the two tariff rates are equal, the beneficial effect of trade creation necessarily dominates the harmful effect of trade diversion. But if t_3 is larger than t_2, the greater expansion in the value of imports of good 2 is not sufficient to guarantee a favorable outcome. For sufficiently low t_2, the beneficial effect of the expansion of imports of good 2 is necessarily outweighed by the harmful effect of the contraction of good 3.

These results imply that, given substitutability, small reductions in t_2 first raise welfare but eventually lower it. Therefore, in general, there is no guarantee that lowering t_2 all the way to zero is welfare improving. This analytic ambiguity assigns a critical role to parameters determining the degree of substitutability between goods 2 and 1 on the one hand and goods 2 and 3 on the other.

Therefore, in the simulations, we need to allow a more general utility function than the standard CES utility function used in the previous section. In particular, the utility function must allow us to distinguish between elasticities of substitution across different pairs of goods. This is accomplished most easily by representing preferences by a nested utility function.

$$(14) \qquad u = [a_1 C_1^{\alpha} + b\chi^{\alpha}]^{\frac{1}{\alpha}},$$

where C_1 is the consumption good 1, produced and exported by A, and χ is a composite good defined over goods 2 and 3, imported from B and C, respectively. The composite good is assumed to have the form

(15) $\chi = [a_2 C_2^{\alpha^*} + a_3 C_2^{\alpha^*}]^{\frac{1}{\alpha^*}}$

Observe that the degree of substitutability between C_1 and χ is $\sigma = 1/(1-\alpha)$, while that between C_2 and C_3 is $\sigma^* = 1/(1-\alpha^*)$. Thus, the present specification allows the degree of substitutability to differ across different pairs of goods. *A priori*, we will expect σ^* to be larger than σ. The U.S. goods, imported into Mexico, are likely to be better substitutes for goods imported from the European Union and Japan than those produced within Mexico. This feature plays a crucial role in determining the outcome in the simulations.

The price of the composite good, defined in (14), is represented by

(16) $\pi(1+t_2, 1+t_3) = [a_2^{\sigma^*}(1+t_2)^{1-\sigma^*} + a_3^{\sigma^*}(1+t_3)^{1-\sigma^*}]^{\frac{1}{1-\sigma^*}}$

Similarly, the expenditure function, corresponding to (15), is given by

(17) $e(1, 1+t_2, 1+t_3)u \equiv [a_1^{\sigma} + b^{\sigma}\pi^{(1-\sigma)}]^{\frac{1}{1-\sigma}} u$

In defining e(.), we take advantage of the fact that π is a function of $1+t_2$ and $1+t_3$, as shown in (16).

Given explicit forms of e(.) and π(.) as in (17) and (16), respectively, equation (10) can be simulated to yield the effects of changes in the values of various parameters on u. Before we do so, however, a key likely result can already be anticipated from our theoretical analysis. In the specific case under consideration, we can obtain

(18a) $e_{21} = \sigma \frac{e_2 e_1}{e} = \sigma e_2 \theta_1$

(18b) $e_{23} = e_2[\sigma \frac{e_3}{e} + (\sigma^* - \sigma)\frac{\pi_3}{\pi}] = e_2[\sigma\theta_3 + (\sigma^* - \sigma)\frac{\pi_3}{\pi}]$

In (18b), π_3 represents the first partial of π with respect to $(1+t_3)$. In addition, we use θ_i to denote the expenditure share of good i. Combining these equations with equation (13), we can conjecture the following results

(i) The larger is σ^* in relation to σ, the less likely that the formation of a free trade area between A and B will improve A's welfare. In the extreme case of $\sigma = 0$, any finite tariff preference must lower A's welfare.

(ii) If $\sigma = \sigma^*$, critical parameters determining the outcome are expenditure shares of goods 1 and 3. The larger the proportion of income spent on home goods relative to outside country's good, the more likely that tariff preference will benefit A.

(iii) To produce significant gains from preferential liberalization, it must be assumed that σ substantially exceeds σ^*.

We may now look at some simulations. Table 2 reports the effects of a removal of the tariff on good 2, amounting to a tariff preference to B, with the external tariff at 15% or 30%. The results do not report on cases with the elasticity of substitution above 2 since the effects are extremely small. In the first two cases for each tariff rate, we assume $\sigma = \sigma^* = .3$ and 2, successively. The net gain is positive, with the maximum gain of .41% of the income arising with the external tariff set at 30% and $\sigma = \sigma^* = 2$. If the tariff rate is set at 15% and $\sigma = \sigma^* = .3$, the gain is .018% of the income.

More strikingly, suppose we assume a low elasticity of substitution between imports from the partner and A's home good and a high elasticity between the two imports. Setting $\sigma = .3$ and $\sigma^* = 2$, the removal of tariff on good 2 leads to a loss of

.052% and .145% of income as the tariff on good 3 is set at 15% and 30%, respectively. Switching these elasticities of substitution turns the loss into a gain in each case.

5. Conclusion

In this paper, we have questioned the results of CGE models demonstrating that preferential liberalization by a country benefits itself. We have argued that these results have been derived from models based on theoretically wrong assumptions. The models combine product differentiation with fixed terms of trade. There is a fundamental tension between these assumptions: if a country is the sole producer of its products, it necessarily has market power. If correct assumptions are made, both theory and numerical simulations are shown to generate losses to the country liberalizing preferentially.

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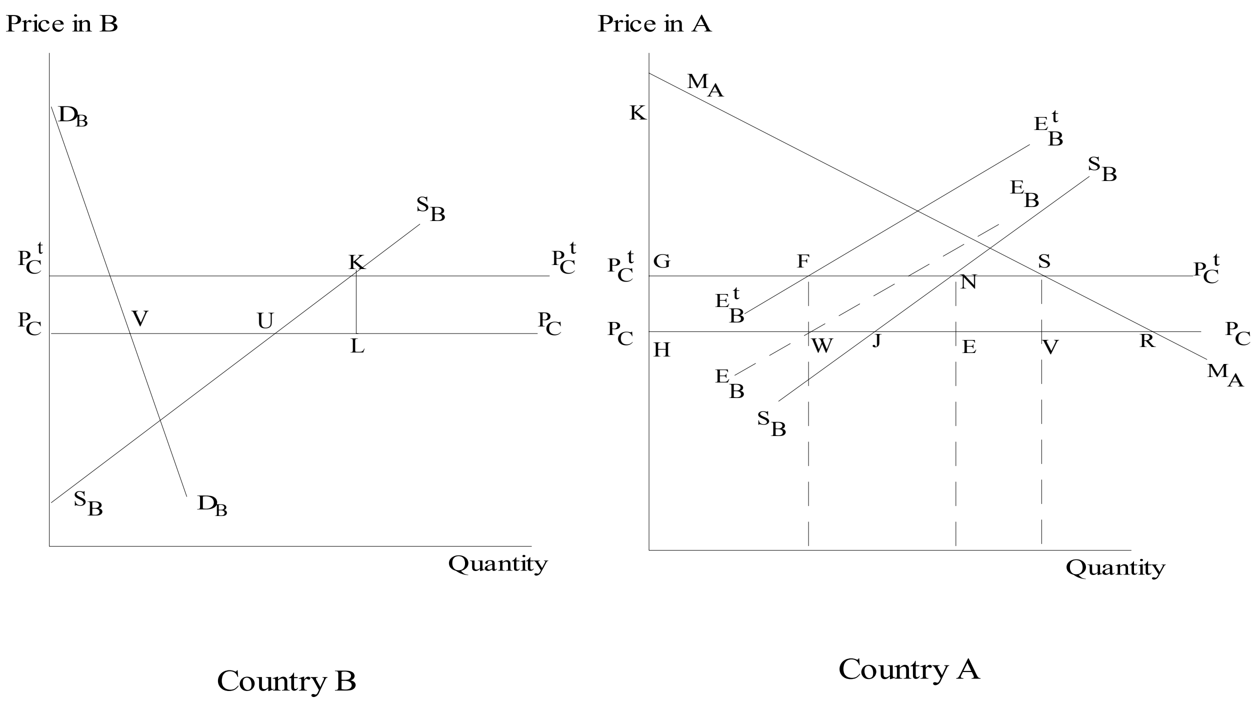

Figure 1: Effects of a Preferential Removal of Tariff by A when Imports Continue to come from C: A loses GNEH, B gains GNJH and the Union Loses JNE (=UKL in the Left-hand Panel)

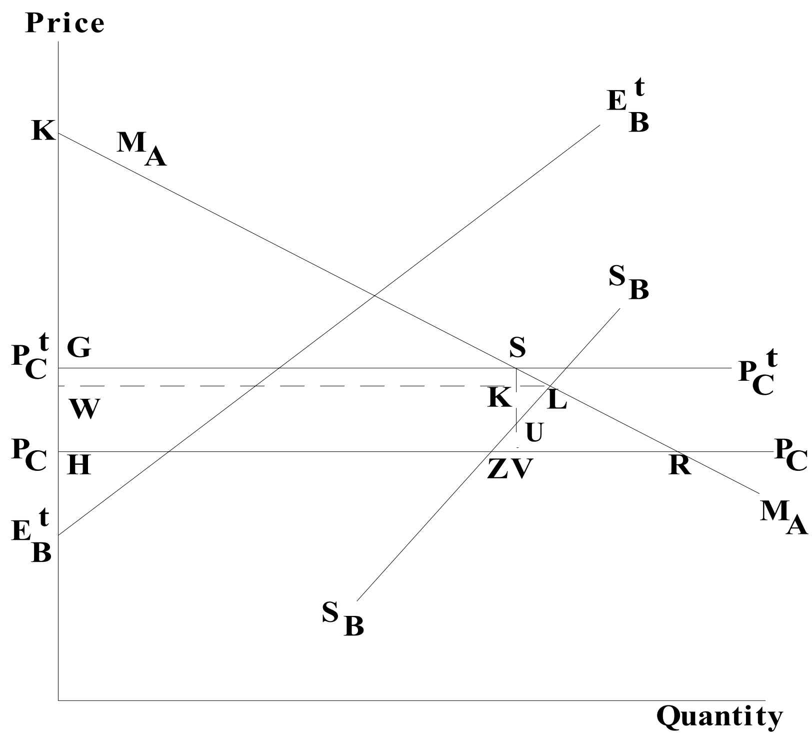

Figure 2: Effects of a Preferential Removal of Tariff by A when C is eliminated as A Source of Imports: A Gains SKL and loses WKVH, B gains WLZH, and the union gains SLU and loses UZV.

TABLE 1: Effects Preferential Liberalization

(Compensating Variation as a **Percent** of the Initial Income)

(Stylized Representation of NAFTA: A = Mexico, B = USA, C = Rest of the world)

σ = 2

Tariff Rate = 15%				Tariff Rate = 30%		
Case	A	B	C	A	B	C
1	-0.78	0.51	-0.31	-2.19	0.97	-0.58
2	-0.76	0.52	-0.30	-2.12	1.01	-0.53
3	-0.80	0.51	-0.32	-2.27	0.99	-0.58
4	4.71	0.16	-0.62	8.63	0.28	-1.12
5	4.87	0.11	-0.65	9.23	0.13	-1.23
6	-5.81	-1.33	0.78	-11.16	-3.09	0.67
7	-1.42	3.05	-2.23	-2.78	5.32	-4.25
8	0.75	-0.05	-0.05	1.36	-0.11	-0.11

σ =10

Tariff Rate = 15%				Tariff Rate = 30%		
Case	A	B	C	A	B	C
1	-2.27	0.11	-0.05	-5.39	0.18	-0.08
2	-2.24	0.14	-0.04	-6.44	0.32	-0.05
3	-2.16	0.14	-0.06	-3.32	0.37	-0.05
4	3.18	0.03	-0.08	4.16	0.072	-0.11
5	5.49	-0.03	-0.14	14.07	-0.008	-0.19
6	-8.63	-3.58	-0.65	-18.54	-7.10	-2.48
7	-1.53	1.57	-1.61	-3.46	0.49	-2.73
8	0.066	-0.004	-0.004	-0.65	-0.013	-0.01

Cases 1-3: Only A liberalizes with respect to B (Case 1: B and C have free trade before as well as after the preference; Case 2: B imposes the MFN tariff before and after the preference but C has free trade; Case 3: B and C both impose the MFN tariff before and after the preference)
Cases 4-5: A and B form FTA with mutual tariff preference (Case 4: C has free trade before and after the FTA; Case 5: C imposes the MFN tariff before and after the preference)
Cases 6-8: The effect of an MFN tariff relative to free trade (Initially, free trade everywhere. Case 6: all three introduce the tariffs, Case 7: only A and B introduce the tariff, Case 8: only A introduces the tariff)

TABLE 2: The Small-Union, Imperfect-Substitutes Model

The Effect of a Unilateral Tariff Preference by A on Itself
(Compensating Variation as a Percent of Income)

σ*	σ	Tariff Preference	
		15%	30%
0.3	0.3	0.018	0.062
2	2	0.127	0.405
2	0.3	-0.052	-0.145
0.3	2	0.102	0.315